CAMBRIDGE

TO: L. S. Shu

DATE: August 4, 1977

FROM: P. M. Carkner

SUBJECT: Monokote Fiber Reduction

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ABSTRACT

This report summarizes the work done to determine if gypsum or sodium metasilicate pentahydrate can act as a "binder" to decrease the number of airborne tremolite fibers from Libby #3 vermiculite.

The presence of gypsum powder appears to drastically reduce the airborne fiber level from L3A as measured by sampling the air during and after "dropping" the materials. It was found that the airborne fiber level was reduced 88 to 94 percent for mixtures of L3A containing 38 to 66 percent by weight gypsum.

The effect of the presence of small amounts of sodium metasilicate pentahydrate in Libby #3 vermiculite on the airborne fiber level is not as dramatic but reductions were found. The fiber level for a 1.0% mixture (wt. % $Na_2Si_2O_5 \cdot 5H_2O$ in L3A) was 18% lower than the control, for a 0.5% mixture the fiber level was 53% lower.

The numbers given in this report should in no circumstance be construed to represent fiber levels present at job site locations. The experimental setup is an arbitrarily designed "drop" system and is intended only for comparing various systems for research purposes.

I. Summary

This work was initiated by E. S. Wood's memo to J. W. Wolter on April 12, 1977 concerning Monokote fiber reduction. The purpose was to investigate the airborne fiber levels of dry blends containing vermiculite (Libby #3) and either gypsum or sodium metasilicate pentahydrate. Specifically, does the gypsum or sodium silicate act as a binder for potential airborne tremolite fibers?

The systems investigated were:

1. Libby #3 expanded on a Model A furnace at Easthampton (5.5 pcf), drops based on 12 and 4 cubic feet of material.

2. 50% and 66% by weight gypsum dry blended with Libby #3 and newsprint - done on 12 and 4 cubic feet L3A basis (i.e., the amount of the mixture dropped contained either 12 or 4 cubic feet of L3A).

3. 38% by weight gypsum and vermiculite mixed and screened through a 30 mesh sieve to remove excess gypsum (attempting to reduce the incidental dust level during the drop test - 38% is the amount of gypsum left after screening). A similarly screened L3A control was done for comparison purposes. Both screened material drops were based on 4 cubic feet of vermiculite.

4. 0.5% and 1.0% by weight sodium silicate pentahydrate ($Na_2Si_2O_3 \cdot 5H_2O$ - Metso Pentabead-20, Philadelphia Quartz Company) dry mixed with Libby #3, Table I gives the formulas for the above systems.

Initially, it was intended to collect data by dropping material containing 12 cubic feet of L3A. Due to the presence of extremely high dust levels in the case of 50 and 66% gypsum mixes, a second set of drops was done using a 4 cubic foot vermiculite basis. The results of both are given in Table II. The presence of a large amount of dust makes it difficult to count fibers on the filter.

The resultant fiber counts are given in Table II. Table III lists T&A numbers pertaining to the fiber count work done by the analytical lab. Table IV gives other information pertinent to the drop tests.

Preliminary work done included the following. Calibration of the Bendix air sampling pumps with a Precision Scientific Wet Test Meter. Air sampling in the presence of gypsum dust (using MK-4 as drop material) in order to establish optimum sampling times and material volume. This was done in conjunction with the analytical lab, the object being not to "overload" the filters with dust so they could still be counted. The gypsum used (standard Easthampton raw material) was checked for the presence of possible interfering fibers (T&A #69500), no fibers were found.

II. Experimental

a) Experimental Materials

On May 3, 1977, 150-4.0 cubic foot bags of Libby #3 were expanded at Easthampton. The density was measured on one bag per pallet, the average was 5.49 ± 0.03 pcf. Thirty bags were shipped to Cambridge to be used as control material, the remainder stored at the plant to be used in blending the other mixes.

On May 12, 1977, the gypsum (50 and 66%) and silicate (0.5 and 1.0%) mixers were made. The procedure was the normal plant Monokote blending process.

b) Bendix Pump Calibration

The air sampling pumps were calibrated at 1.6 l/min. with a Precision Scientific Wet Test Meter, according to the instructions provided for both instruments.

c) Drop Test Procedure

(1) Prior to each run previously dropped material, the floor, stairs, hopper, and platform were vacuumed.

(2) Load hopper with a previously weighed or measured amount of material to be dropped.

(3) Allow exhaust fan to run 10 to 15 minutes.

(4) Turn off fan, close doors.

(5) Set up sampling pumps at locations A & B (facing hopper stairs, A is on left forward post, B on left rear post) - connect cassette to column flow meter, meter to Bendix pump.

(6) Open chute to desired width, simultaneously starting stopwatch and pumps, immediately adjust flow rate to 1.6 l/min.

(7) After each sample interval, change cassette and restart stopwatch, flow rate must be adjusted for each new cassette.

(8) When sampling sequence is completed, store cassettes, open doors and turn on exhaust fan.

In all of the drops done here a preliminary 30 minute background sample was taken at each location. Air was sampled for 30 minutes starting when the chute was opened, sampling periods were sequentially 5', 5', 10', 10'.

The systems in Table II having four data points per sample period were dropped in duplicate, those with two data points were done once.

In most cases the filters were weighed before and after sampling and a dust index (mg/M^3 of air) calculated.

The large column flow meters were used in order to read the flow rate accurately. The flow rate was either adjusted to maintain a 1.6 l/min or recorded at intervals and a total air volume calculated.

Twelve cubic foot drops of mixes containing newsprint and gypsum would not flow down the hopper without using a vibrator and manually pushing the material towards the center of the hopper. The vibrator used was a cylindrical (around 1 inch diameter) cement vibrator suspended in the center of the hopper. Six crossbars were clamped to the vibrator in order to expand its "sphere of influence".

d) Fiber Counting

See Julie C. Yang's memo of January 28, 1976, File 71-047.

3) Original data for this work can be found in notebooks #85 and 112.

III. Results and Discussion

The dust levels (amount of dust present in the air being sampled during the drop tests) for the various systems are shown in Figures 1a through 1d. The presence of this nuisance dust necessitated rerunning the 50 and 66% gypsum mixes with smaller quantities of material. Data was initially collected on drops based on 12 cubic feet of L5A. This base was reduced to 4 cubic feet and a second set of data collected, see Table II and Figure 3.

It is apparent from the data that the airborne fiber level in the vicinity of free-falling vermiculite/gypsum mixtures is significantly lower than that for the corresponding amount of pure vermiculite (see Table II and Figure 2). The 30 minute time weighted average fiber/cc count is decreased by 88 to 94% for the gypsum mixtures used (38 to 66% gypsum). The percentage of gypsum in Monokote formulations varies from 62 to 65 percent, the same range looked at in these experiments.

The 4 cubic feet screened control showed a fiber level 10% lower than the corresponding unscreened 4 cubic foot control.

The results in the case of sodium silicate containing mixes shows a 53% reduction in fiber count for 0.5% $Na_2Si_2O_3 \cdot 5H_2O$ and an 18% reduction for 1.0% $Na_2Si_2O_3 \cdot 5H_2O$, see Table II and Figure 3.

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Attachments/Tables I, II, III, IV
Figures 1 (a-d) 2, and 3 (a-c)

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Table I[1]

Formula 112-6-A[2]

250 lb. gypsum (49.6%)
220 lb. L3A (43.7%)
33.3 lb. Newsprint (6.6%)

Formula 112-6-B[2]

500 lb. gypsum (66.4%)
220 lb. L3A (29.2%)
33.3 lb. Newsprint (4.4%)

Formula 112-6-C[2]

220 lb. L3A
1.1 lb. $Na_2Si_2O_3 \cdot 5H_2O$ (0.5%)

Formula 112-6-D[2]

220 lb. L3A
2.2 lb. $Na_2Si_2O_3 \cdot 5H_2O$ (1.0%)

Formula 112-51[3]

13.7 lb. gypsum (38.3%)
22.0 lb. L3A (61.7%)

[1]All vermiculite used including control material was expanded during the same run and notebook coded 112-5.

[2]Made in ribbon blender at Easthampton

[3]Hand mixed at Cambridge - excess gypsum was screened out - numbers given are after screening.

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Table II

Airborne Fiber Data

Material	Fibers/cc During Indicated Sampling Period				
	0-5'	5-10'	10-20'	20-30'	30 TWA[1]
112-5	24.80	21.38	2.99	7.27	11.12
12 c.f. L3A Control	17.23	18.51	7.37	5.92	10.39
	16.25	15.39	6.41	3.85	8.69
	17.10	12.83	7.86	4.62	9.15
					$\bar{x}$ = 9.84
112-6-A	-[2]	0.91	0.88	<0.43	<0.75
50% Gypsum	0.94	-[2]	-[2]	0.43	-
containing 12 c.f.	2.07	-[2]	-[2]	0.46	-
L3A	<0.95	-[2]	-[2]	0.44	-
					$\bar{x}$ =<0.75
112-6-B	<1.00	<0.87	<0.44	0.44	0.61
66% Gypsum	-[2]	1.78	<0.48	1.32	-
containing 12 c.f.	-[2]	1.71	0.44	0.87	-
L3A	-[2]	1.98	0.44	1.07	-
					$\bar{x}$ =<0.61
112-5	12.83	6.84	5.13	2.99	5.99
4 c.f. L3A Control	13.96	6.51	3.37	2.10	5.24
	13.33	5.99	4.28	2.57	5.35
	24.27	1.71	2.90	2.44	6.11
					$\bar{x}$ = 5.80
112-6-A	0.86	0.86	<0.43	0.43	< 0.57
50% Gypsum	1.00	1.10	-[3]	<0.43	-
containing 4 c.f.	0.86	0.86	0.86	<0.43	< 0.72
L3A	1.00	0.92	0.94	0.47	0.79
					$\bar{x}$ =<0.69
112-6-B	0.86	0.86	<0.43	<0.43	< 0.57
66% Gypsum	<1.00	<0.86	<0.49	<0.44	< 0.62
containing 4 c.f.	0.86	0.86	<0.43	<0.43	< 0.57
L3A	<1.03	<1.08	<0.49	<0.55	< 0.70
					$\bar{x}$ =<0.62

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Table II (Continued)

Airborne Fiber Data

Material	Fibers/cc During Indicated Sampling Period 0-5'	5-10'	10-20'	20-30'	30' TWA
112-51	< 0.86	< 0.86	< 0.43	< 0.43	< 0.57
38% Gypsum	1.00	< 1.10	< 0.47	< 0.53	< 0.68
containing 4 c.f. L3A screened					
				$\bar{x}$ =	< 0.63
112-52	11.97	5.99	5.56	1.28	5.27
4 c.f. L3A Control	6.84	11.03	4.41	2.21	5.19
screened					
				$\bar{x}$ =	5.23
112-6-C[4]	4.28	8.55	2.99	1.28	3.56
0.5% sodium	9.26	4.99	2.59	4.49	4.74
silicate pentahydrate	11.97	5.99	2.14	5.13	5.42
containing 12 c.f. L3A	7.70	4.99	4.43	3.68	4.82
				$\bar{x}$ =	4.63
112-6-D[4]	14.54	11.97	5.99	4.76	8.00
1.0% sodium silicate	12.83	13.87	6.69	4.63	8.21
pentahydrate	-[2]	6.84	4.28	4.70	-
containing 12 c.f. L3A	-[2]	14.15	7.89	2.99	-
				$\bar{x}$ =	8.11

[1]TWA ≡ Time Weighted Average

[2]Filters too dusty to be read

[3]Filter dropped during analysis - not read

[4]For comparison, see 112-5, 12 c.f. L3A Control

[5]To compare f/cc with clean filter values, see 112-5, 4 c.f. L3A Control

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Table III

T&A No.	Material		
65000	112-6-B	12 c. f. base	(66% gypsum)
65001	112-6-A	12 c. f. base	(50% gypsum)
65002	112-6-C	12 c. f. base	(0.5% silicate)
65003	112-6-D	12 c. f. base	(1.0% silicate)
65004	112-5	12 c. f. base	(L3A control)
65005	112-5	4 c. f. base	(L3A control)
65006	112-6-A	4 c. f. base	(50% gypsum)
65007	112-6-B	4 c. f. base	(66% gypsum)
65008	112-5	4 c. f. base	(L3A control
	112-51	4 c. f. base	(38% gypsum - screened)
	112-52	4 c. f. base	(screened L3A control)

Table IV

Miscellaneous Drop Data

Material	Drop Time (min)	Chute Opening	Quantity of[1] Material Dropped
L3A control - 12 c.f. base	3.00[2]	1.55"	66 lb.
50% gypsum - 12 c.f. base	3.20[2]	3.75"(full open)	151 lb.
66% gypsum - 12 c.f. base	3.17[2]	3.75"(full open)	226 lb.
L3A control - 4 c.f. base	1.0[2]	1.55"	22 lb.
50% gypsum - 4 c.f. base	0.67[2]	3.75"(full open)	50.3 lb.
66% gypsum - 4 c.f. base	0.92[2]	3.75"(full open)	75.3 lb.
38% gypsum - screened, 4 c.f. base	0.92	1.55"	35.7 lb.
L3A control - screened, 4 c.f. base	1.00	1.55"	22.0 lb.
0.5% sodium silicate - 12 c.f. base	2.20	1.55	66 lb.
1.0% sodium silicate - 12 c.f. base	2.30	1.55	66 lb.

[1]All quantities are weights of material containing 12 or 4 c.f. of L3A

[2]Average of 2 drops

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AVERAGE DUST LEVELS VS. TIME

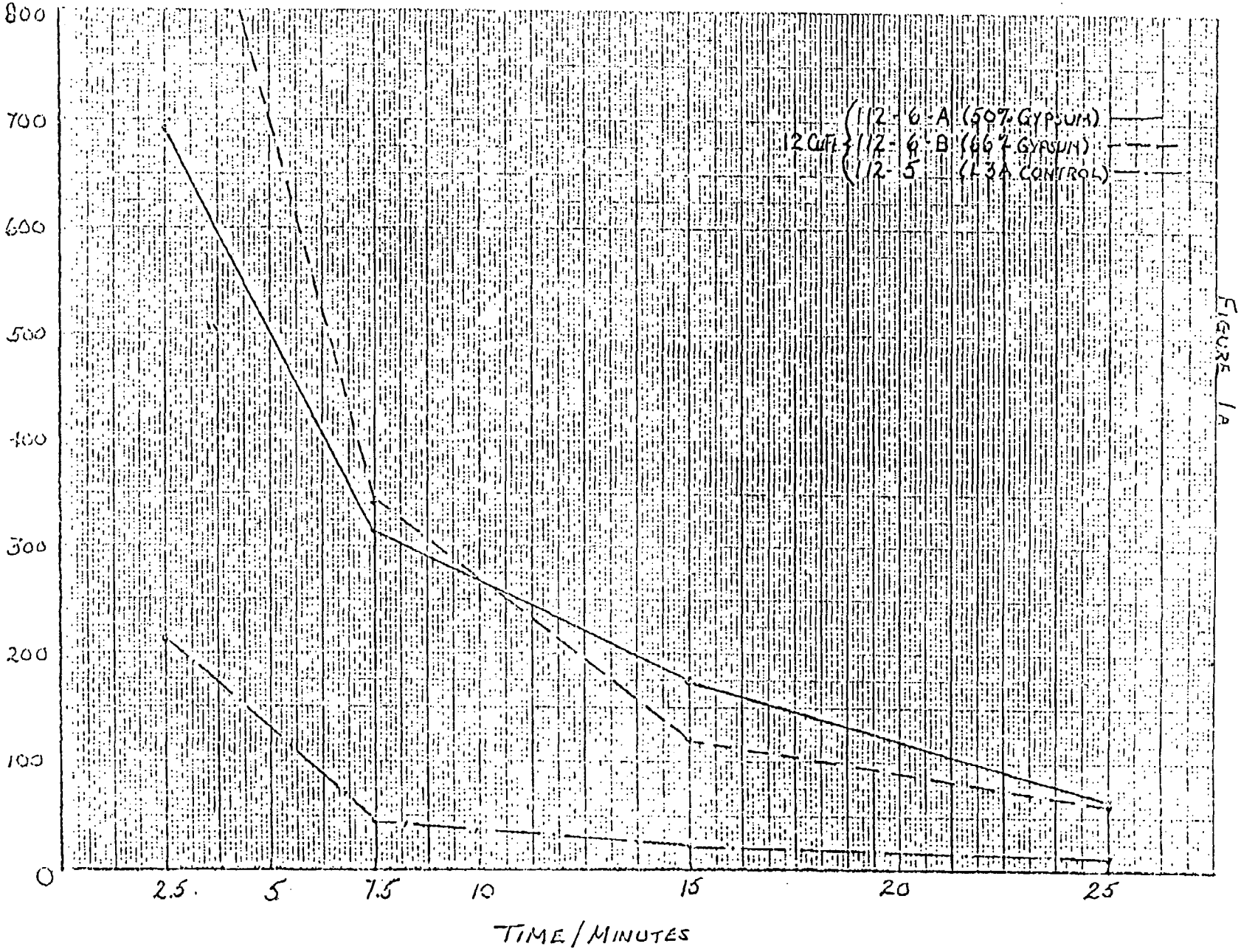

FIGURE 1A

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AVERAGE DUST LEVELS VS. TIME

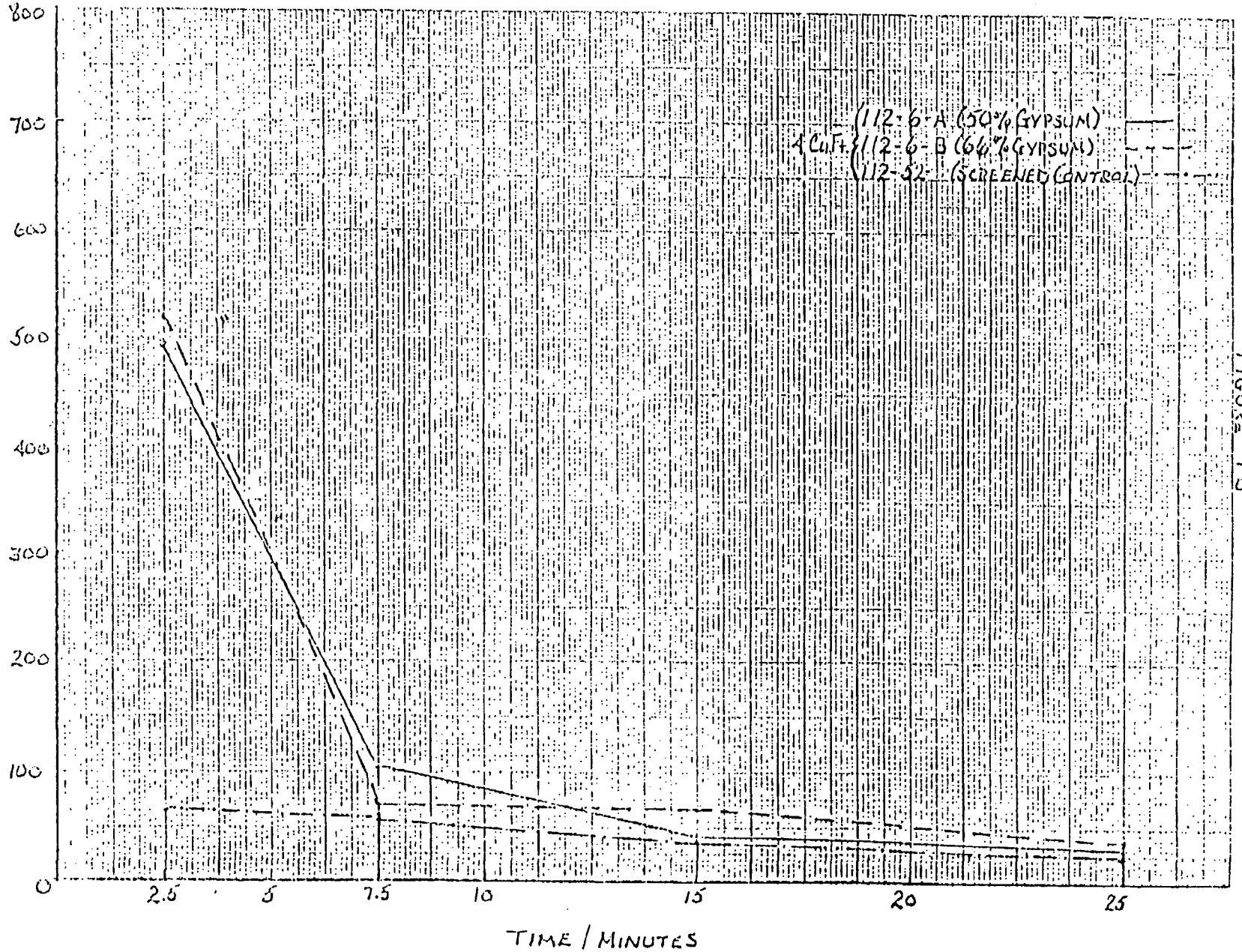

FIGURE 13

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AVERAGE DUST LEVEL VS. TIME

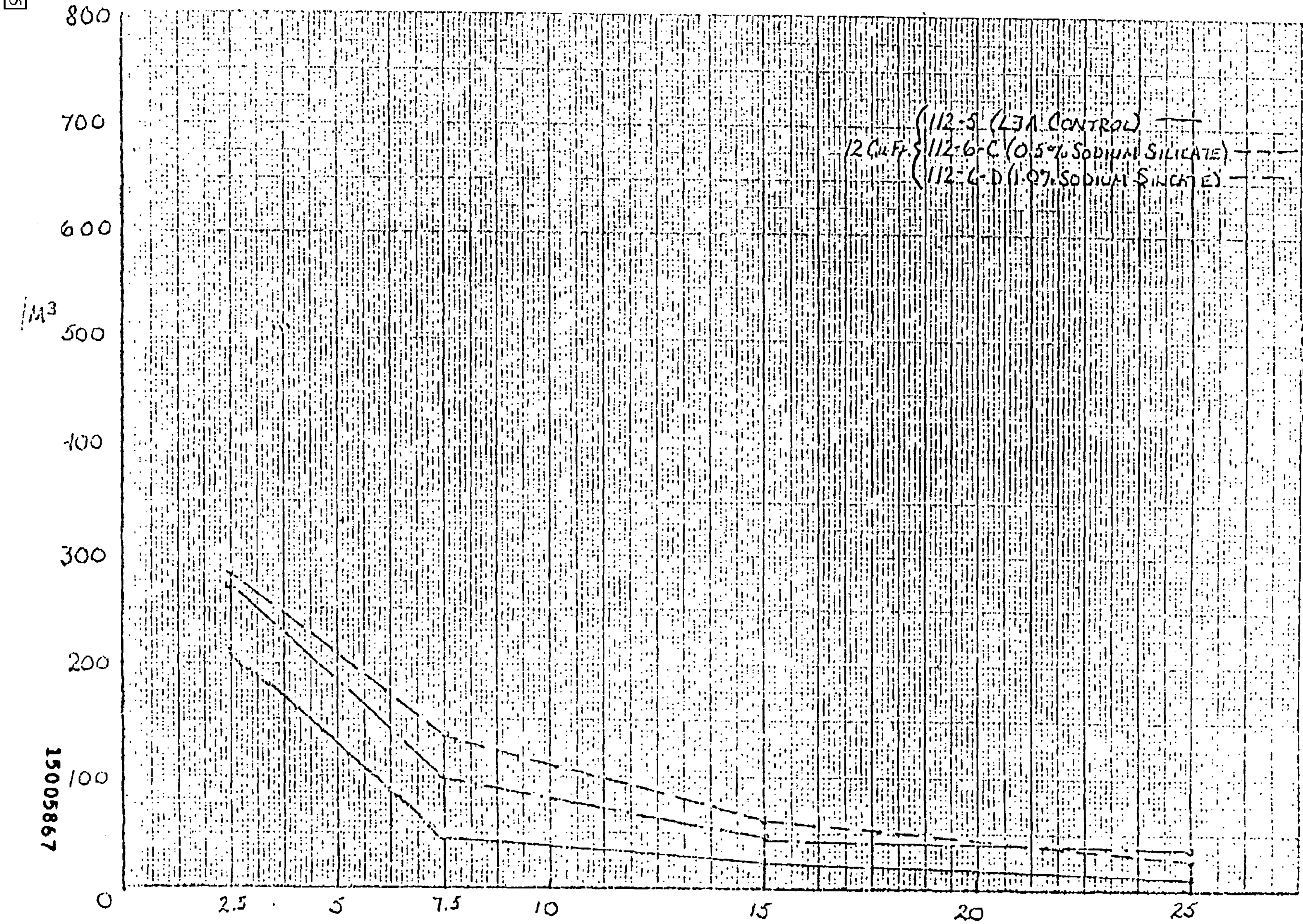

FIGURE 1C

IV

Average Dust Levels vs. Time

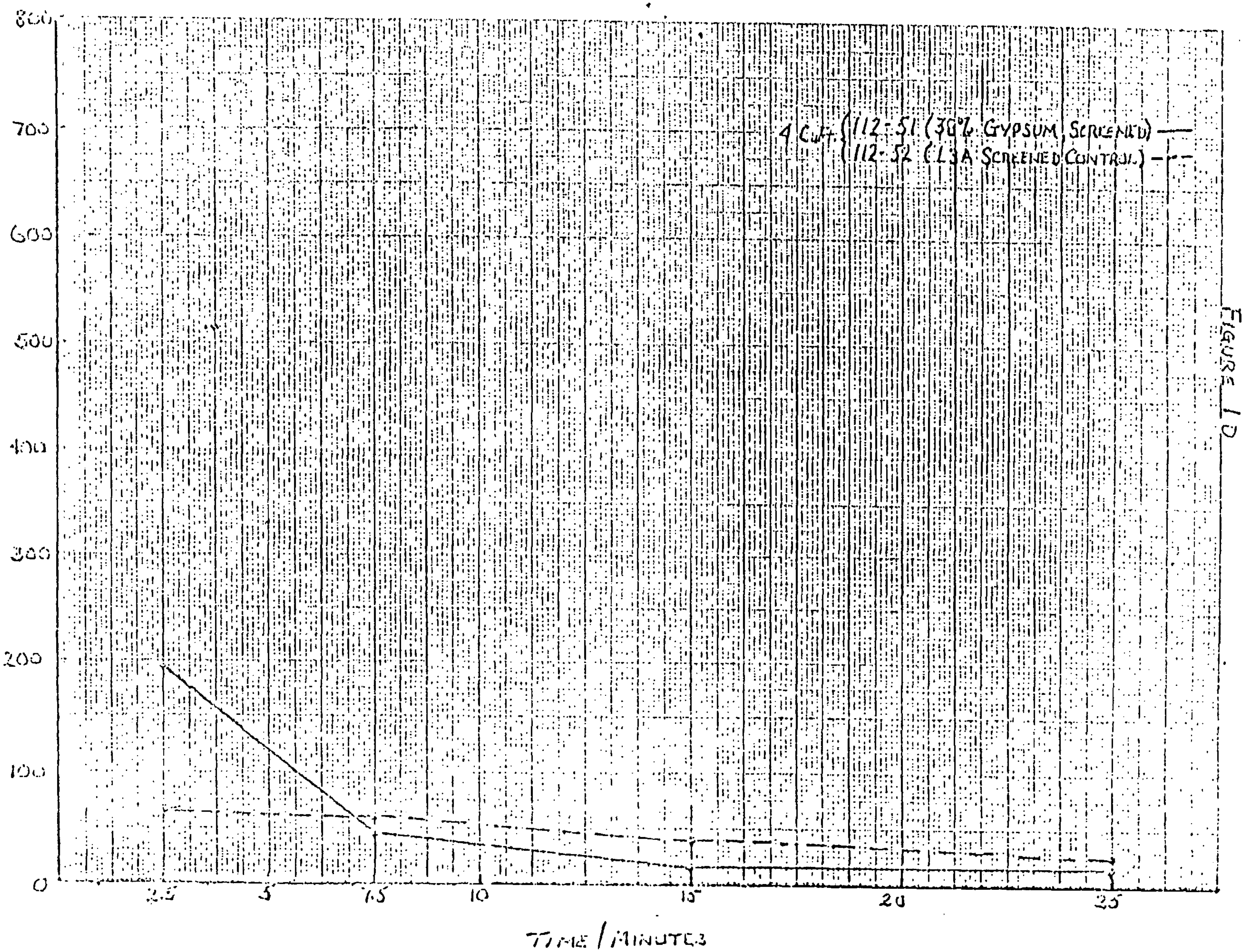

Figure 1 D

FIGURE 2

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FIBER LEVELS AS A FUNCTION OF THE PERCETAGE OF GYPSUM

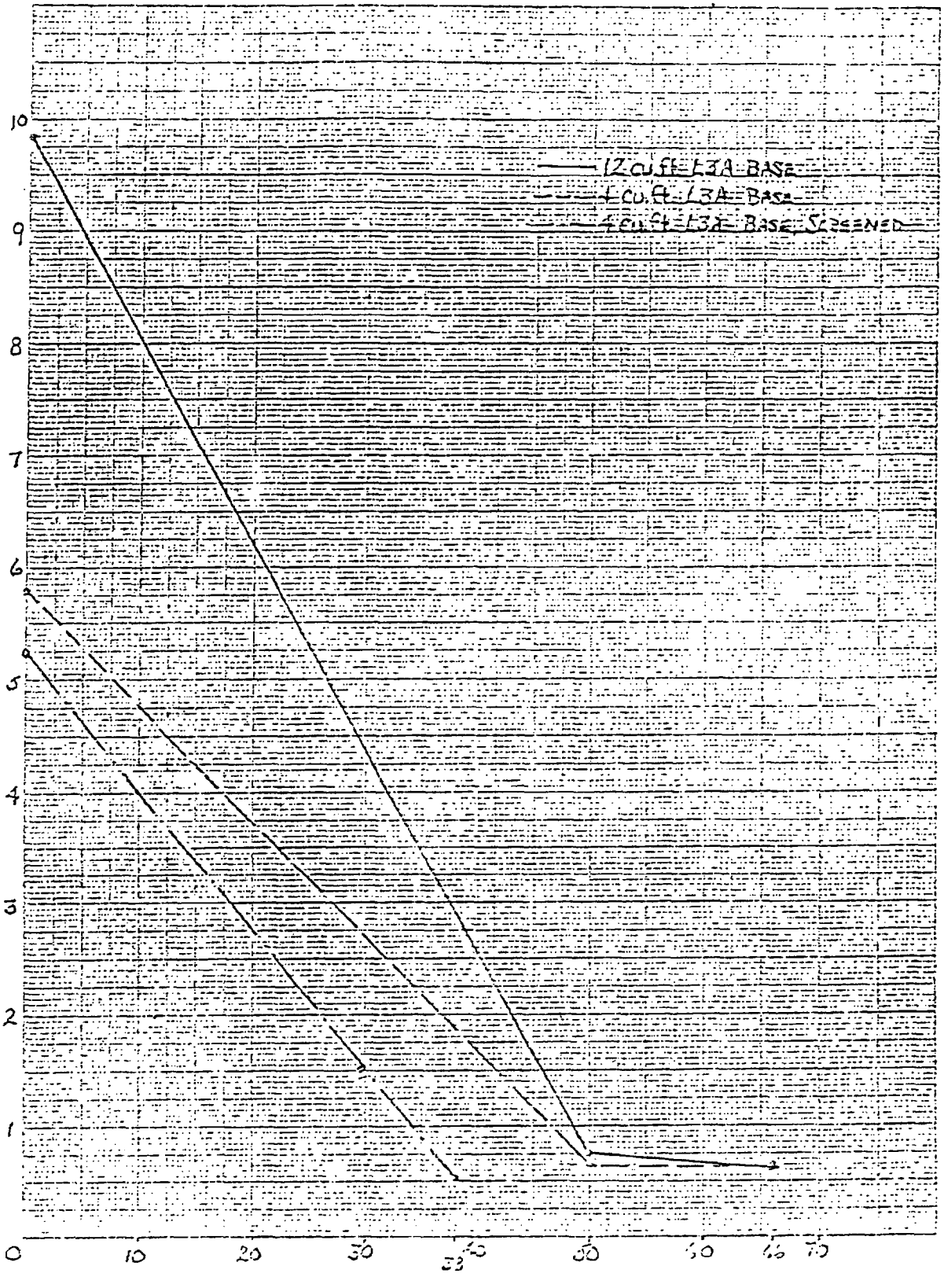

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FIGURE 3A

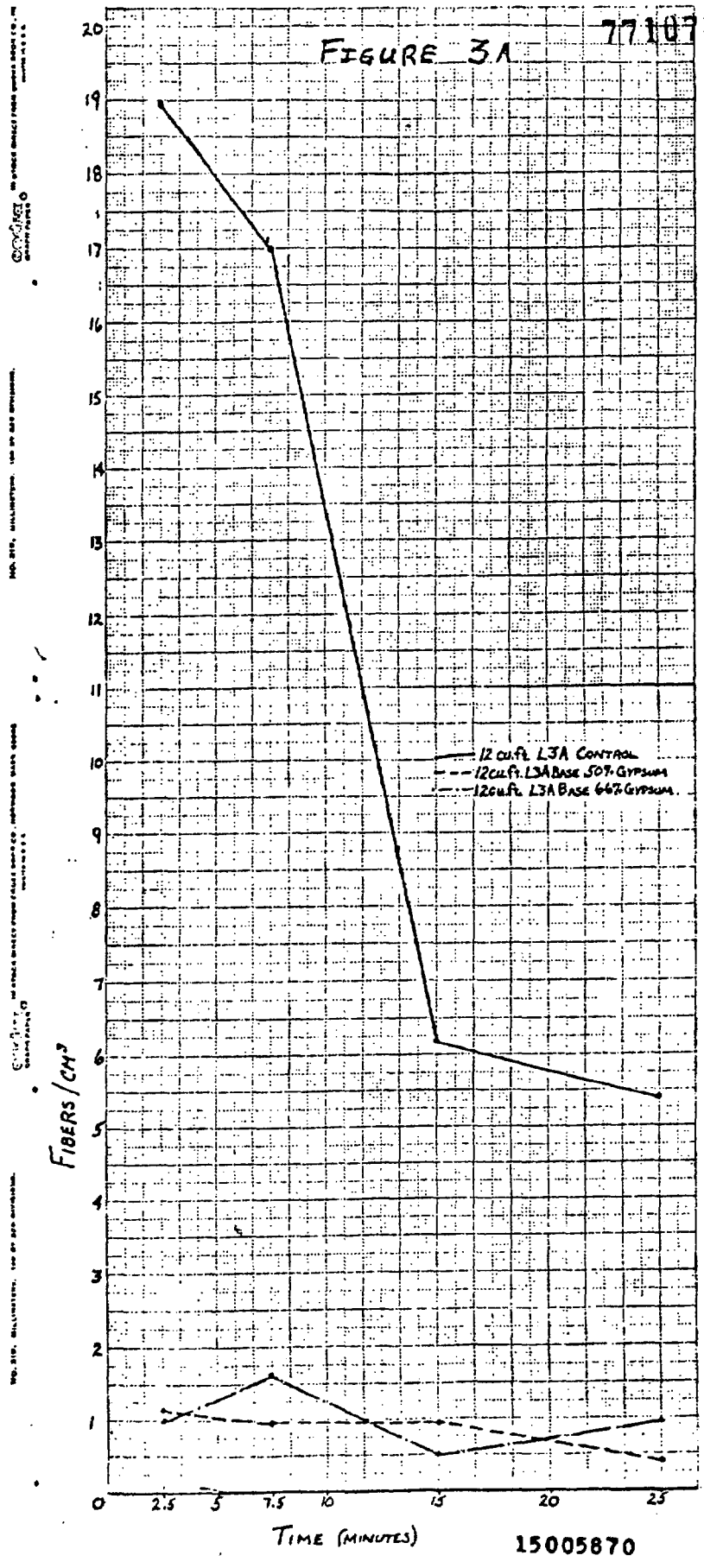

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FIGURE 3B 771079

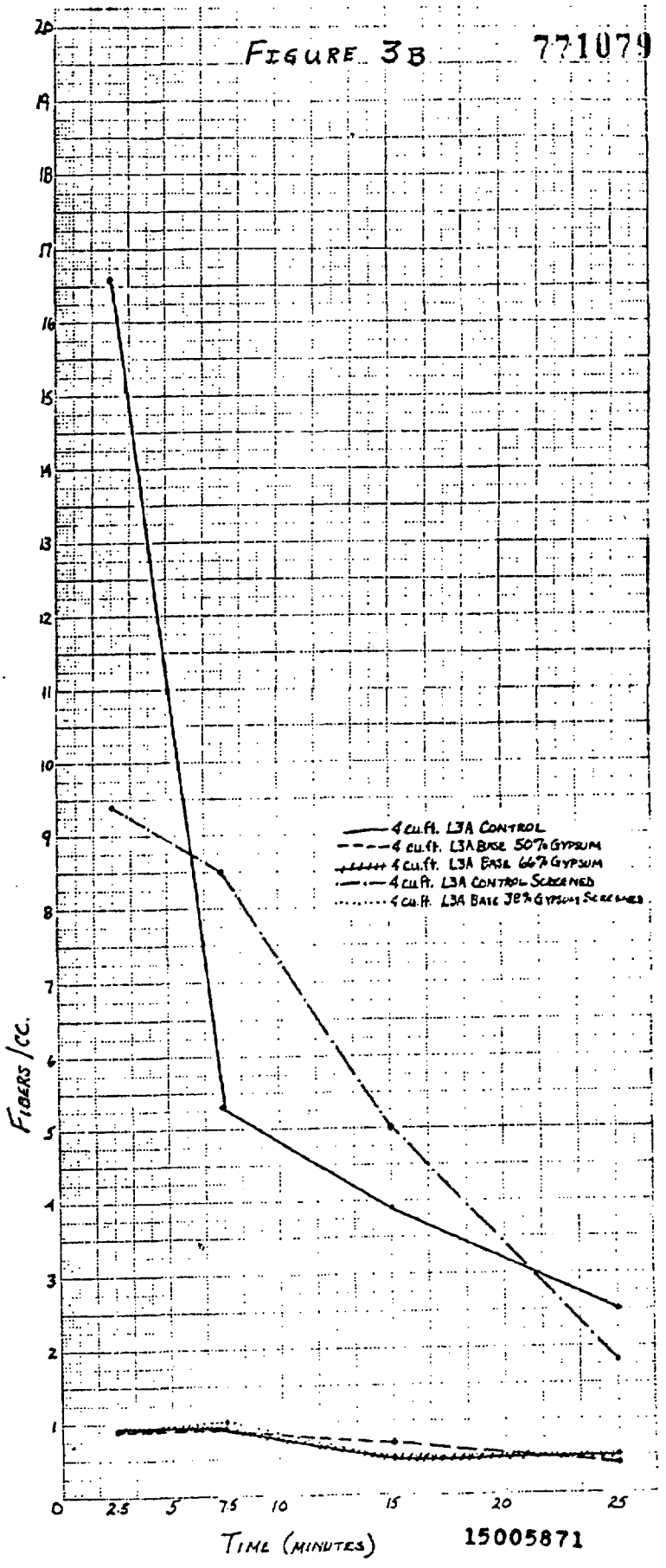

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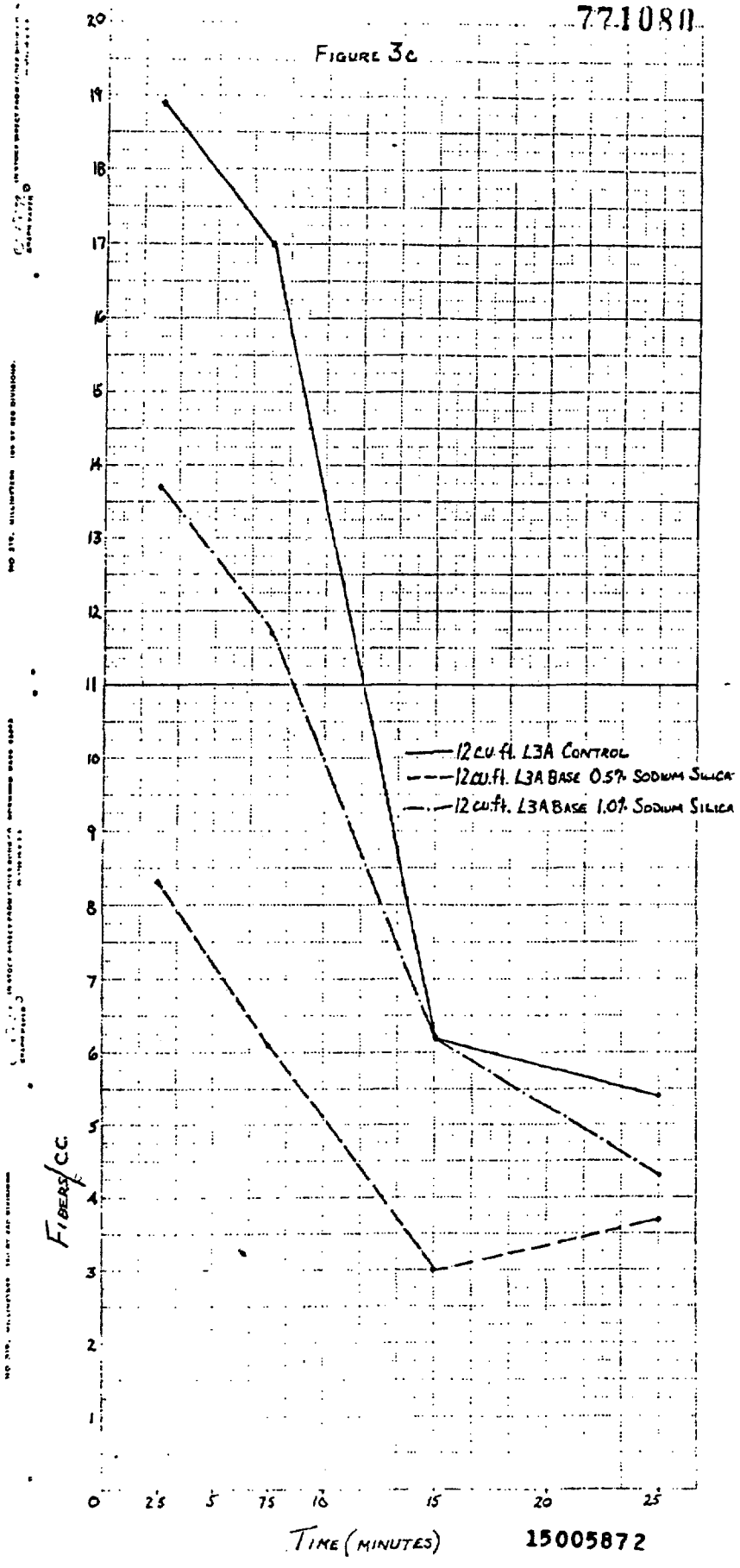
FIGURE 3c



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